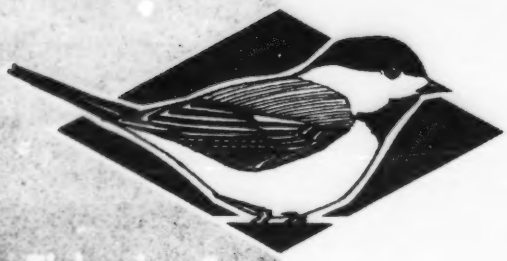
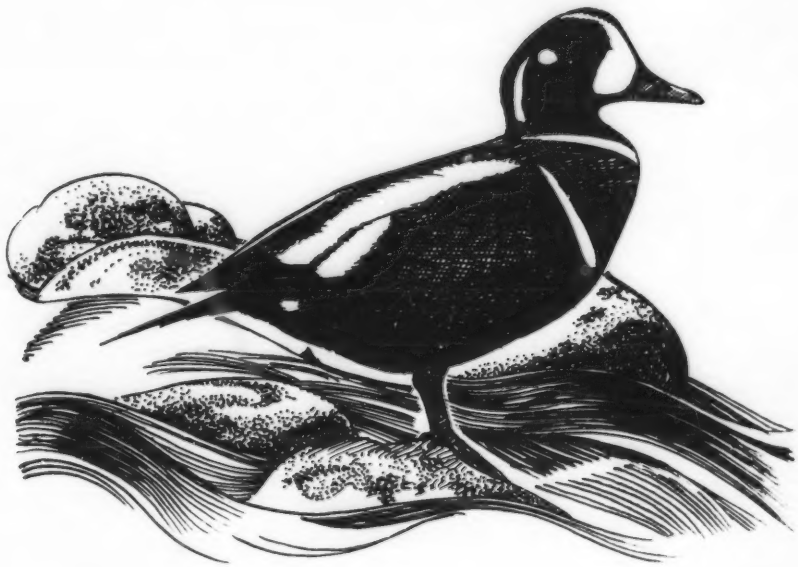


Fisheries & Wildlife Management Division

RESOURCE STATUS AND ASSESSMENT BRANCH

Status of the Harlequin Duck (Histrionicus histrionicus) in Alberta

Beth MacCallum



Alberta Wildlife Status Report No. 36

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APPENDIX 2. continued

Place Name	Location	Status (a)	Source (b)	Comments
Amethyst Lake	83 D/9	Unknown	2. 6. 20.	1 pair July 6 1978; regularly observed since 1991
Lac La Biche	73 L/13, 83 I/16	Unlikely	2. 29.	1♀ October 16 1993
Lake Newell	Brooks 72 L/5	Unlikely	2.	1♂ June 27 1997
Little Buffalo River	Wood Buffalo National Park 84 C/8	Unlikely	2. 32.	wintering record
Little Fish Lake	Drumheller 82 P/8	Unlikely	2. 34.	4♀ September 11 1993
Muskeg River (tributary)	North of Ft. McKay 74 E	Unlikely	2. 12. 30.	1♂ June 1977
North Saskatchewan River	Goldbar Park, Edmonton 83 H/11	Unlikely	2. 29.	winter record Goldbar Park December 18 1994; 1♀ October 4 1996 in Edmonton

(a) The status of streams on which Harlequin Ducks have been observed in Alberta are classified as: breeding, probable breeding, unknown and unlikely breeding. Definitions were modified from Cassirer et al. (1996) as follows: Harlequin Duck Breeding Stream - A drainage/portion of a drainage used by Harlequin Ducks where breeding is known i.e. a brood or nest has been observed within the past 15 years (1986-2000). Comprised of contiguous stream reaches (and portions of lakes, reservoirs, or bays) used during the nesting and brood-rearing periods. Breeding may be delineated based on known Harlequin Duck movement patterns where this information is available. Probable Harlequin Duck Breeding Stream - A drainage/portion of a drainage used by Harlequin Ducks where breeding is highly suspected i.e. there have been at least 3 independent pair or female observations within the last 15 years (1986-2000). Comprised of contiguous stream reaches (and portions of lakes, reservoirs, or bays) used during the nesting and brood-rearing periods. Breeding Status Unknown - A drainage/portion of a drainage with < 3 independent pair or female observations during the breeding season. Breeding Unlikely - Observations of males during migration (before April 15 and after July 15) or Observations of females during migration (before April 20 and after September 30). Nonbreeding and failed breeding hens generally leave the breeding streams early to mid-August or Observations of pairs outside the breeding season (before April 20 and after July 15) or Incidental observations in unsuitable habitat such as ponds, or large, low gradient (<1%) rivers, not adjacent to known breeding sites, or observations on streams which have been identified as lacking breeding activity (e.g. migratory staging areas or stopovers).

(b) Sources: **1.** AGRA Earth & Environmental. 1998. Sphinx West wildlife study. Appendix 7 Volume III Pp.30-35 in Gregg River Mine Sphinx West Area, application for amendment to Environmental Protection and Enhancement Act approval 11903-01 and Water Resources Act approval, April, 1998. Manalta Coal Ltd., Gregg River Mine, Hinton, AB; **2.** Alberta Environment. 199? Harlequin Duck Observations in Alberta, 1874-1999. Prepared by Bighorn Environmental Design Ltd., Hinton, AB for Alberta Natural Resources Service, Wildlife Management Division, Status and Surveys Branch, Edmonton, AB; **3.** Allen, J. 1998. Blackstone River Harlequin Duck survey May 20 and 21, 1998. Alberta Environmental Protection, Natural Resources Service, Rocky Mountain House, AB. 2pp; **4.** Bighorn Environmental Design Ltd. 1996. Cumulative effects and environmental assessment of the proposed Cheviot Mine Development: Ungulates, Small Mammals, Avifauna, Amphibians. 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PREFACE

Every five years, the Fisheries and Wildlife Management Division of Alberta Natural Resources Service reviews the status of wildlife species in Alberta. These overviews, which have been conducted in 1991, 1996 and 2000, assign individual species 'ranks' that reflect the perceived level of risk to populations that occur in the province. Such designations are determined from extensive consultations with professional and amateur biologists, and from a variety of readily available sources of population data. A primary objective of these reviews is to identify species that may be considered for more detailed status determinations.

The Alberta Wildlife Status Report Series is an extension of the general statusing exercises (1996 *Status of Alberta Wildlife, Status of Wild Species in Alberta* 2000), and provides comprehensive current summaries of the biological status of selected wildlife species in Alberta. Priority is given to species that are potentially at risk in the province (at risk, may be at risk), that are of uncertain status (status undetermined), or which are considered to be at risk at a national level by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Reports in this series are published and distributed by the Alberta Conservation Association and the Fisheries and Wildlife Management Division of Alberta Environment, and are intended to provide detailed and up-to-date information which will be useful to resource professionals for managing populations of species and their habitats in the province. The reports are also designed to provide current information which will assist the Alberta Endangered Species Conservation Committee to identify species that may be formally designated as endangered or threatened under the Alberta Wildlife Act. To achieve these goals, the reports have been authored and/or reviewed by individuals with unique local expertise in the biology and management of each species.

EXECUTIVE SUMMARY

The Harlequin Duck (Histrionicus histrionicus) is a small sea duck that winters along rocky coastlines at traditional sites and migrates inland to breed on swift flowing, clear mountain streams. It is a long-lived species possessing characteristics which could potentially make it vulnerable to human-induced disturbance. Lack of information on biology of the Harlequin Duck and specifically information on their abundance and distribution in Alberta has hampered the understanding of this species and its status. The Harlequin Duck is currently considered 'sensitive' in Alberta. Several other agencies in western North America have identified the Harlequin Duck to be of special management concern. The eastern population of Harlequin Duck is listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as 'endangered'.

In Alberta, harlequins breed in a 53 000 km^2 area located in the mountain and foothill portions of the Smoky, Athabasca, North Saskatchewan, Red Deer, Bow and Oldman River watersheds; 49% of this area falls within protected parks, wildlands and wilderness areas. Harlequins have been reported on 177 rivers and streams and 56 lakes and ponds within their breeding range in Alberta. These comprise 39 breeding and 8 potential breeding occurrences. No population estimate of breeding harlequins is available from survey information, but based on existing knowledge a preliminary projection of the minimum population of harlequins breeding in Alberta is 1600 - 4000. Populations on the Elbow, Bow and McLeod Rivers appear stable based on estimates over 4 - 5 years.

Recent research on harlequin populations of the Bow, Kananaskis, Elbow, Maligne, and McLeod Rivers has provided insight into population characteristics, habitat requirements, movement patterns, migration, and response to recreational disturbance in Alberta. Concerns regarding human impacts on local populations has resulted in the implementation of recreation restrictions on various rivers in Alberta as well as development of site specific mitigation for potential industrial impacts. The results of regional inventories initiated in the southern, central and northern foothills are being used in conjunction with habitat and land-use information to further refine the understanding of environmental limiting factors and potential human impacts on the Harlequin Duck in Alberta.

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The distribution section was prepared using records from Albertas Biodiversity/Species Observation Database to which many people contributed. Thanks go to the staff of Jasper, Banff and Waterton Lakes National Park for providing access to their databases, especially Ward Hughson, Charlie Pacas, Cyndi Smith, Kevin VanTighem and Rob Watt. David Poll searched CanSIS records. Jim Allen, Jim Clark, David Hobson, Jeff Kneteman and Wayne Norstrom provided results from Alberta Environment surveys. Paul Gregoire made available surveys from Canadian Wildlife Service. Gavin More and John Rintoul provided historical records for the province, as did David Ealey for the Sheep and Elbow Rivers. Staff of the Canadian Museum of Nature, Alberta Provincial Museum, University of Alberta Zoology Museum, University of Calgary Zoology Museum and the Banff Museum provided records. Thanks to Trevor Weins, Federation of Alberta Naturalists who provided breeding bird atlas data and contacts. The following Alberta Bird Atlas contributors provided records for use in BSOD: Charles Adolewski, Suzanne Benoit, Rick Bonar, Wes Bradford, Marilyn Christiansen, Gary Clarke, Ross Dickson, Ian Halladay, Clay Hunt, Ellen Johnson, Edgar Jones, Carole Petersen, Dodie Pollard, Alex Mills, Richard Quinlan, Janice Smith, and Dave Sheppard. Personal records were also provided by Ken Bailey, Eldon Bruns, Doug Collister, Dave Duncan, Trent Enzsol, Bob Glidden, Dave Hervieux, Dave Hobson, Greg Horne, Carl Hunt, Craig Johnson, Keith Linderman, Beth MacCallum, Bob and June Neufeld, Don Pattie, Margo Pybus, Wayne Roberts, Kirby Smith, Chris Spytz, George Sterling, Mike Sullivan, Ian Tarr, and Rick Zroback.

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INTRODUCTION

The Harlequin Duck (Histrionicus histrionicus) is a small sea duck with a Holarctic distribution. These ducks winter along rocky coastlines at traditional sites where they form pair bonds, and in spring they fly inland to breed in swift-flowing mountain streams. Breeding populations occur in northwestern North America, eastern Canada, Greenland, as well as Iceland and eastern Siberia (Bengtson 1972). In 1990, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated the eastern North American population of Harlequin Duck as 'endangered' due to declines in the 20th century. Western populations of Harlequin Duck are not listed by COSEWIC but most agencies identify these populations to be of special management concern because of the life history strategy and specialized breeding habitat requirements of the species. The Harlequin Duck is ranked 'sensitive*' in Alberta (Fisheries and Wildlife Management, in prep.).

Until recently the Harlequin Duck has been an understudied species leading some authors to conclude that their protection and management may be constrained by a lack of information on basic biology and distribution (Breault and Savard 1991). Recent studies have increased knowledge of Harlequin Duck ecology, distribution, abundance and habitat use in Alberta as well as winter ecology on coastal moulting and wintering grounds (Cooke et al., 1997 and 2000, Gowans et al., 1997, Robertson 1997, Robertson et al., 1998a, 1998b, and Smith et al., 1998). This report reviews and summarizes current information on the status of the Harlequin Duck in Alberta as a step in updating its status in the province.

* See Appendix 1 for definitions of selected status designations.

HABITAT

The Harlequin Duck spends most of its life cycle in coastal intertidal zones, feeding, loafing and roosting along rocky shores. In its breeding range, it requires a specific set of habitat and stream quality characteristics for breeding and raising young. Good breeding habitat for the Harlequin Duck contains vegetation cover on islands and shorelines, clear water, islands in mid-stream, braided channels, lower gradients, and cobble and boulder substrates. Clarity of water is important to harlequins as they are visual feeders preying on invertebrates located in the bottom substrate. Cassirer et al. (1996) listed the following characteristics as typical of Harlequin Duck breeding streams in the U.S. Rocky Mountains: stream size second-order or greater; reaches on streams with average gradient between 1% and 7%, with some areas of shallow water (riffles); clear water; rocky, gravel to boulder-size substrate; and forested bank vegetation. Some factors that may increase the likelihood of use by Harlequin Ducks were listed as: proximity to occupied habitat; hiding cover along the stream, including overhanging shrub vegetation, logjams, undercut stream banks, woody debris and instream loafing sites (boulders or gravel bars adjacent to swiftly flowing water); absence of human disturbance such as boating, fishing and residences; and lack of access by road or trail.

Vegetation on islands and shorelines appears to be important for Harlequin Ducks. Nest sites are located in dense vegetation and hens with broods make frequent use of vegetation cover along the stream for concealment (Bengtson 1966, Kuchel 1977, MacCallum, unpubl. data, Rodway 1998a). Bank vegetation found along Harlequin Duck breeding streams is highly variable. Spruce forests and willow thickets are common in Labrador (Rodway 1998a),

willow shrub or pole or immature-sized lodgepole pine (Pinus contorta), Engelmann spruce, and Douglas-fir (Pseudotsuga menziesii) forest are found in Wyoming, Montana and Idaho, mature or old growth western red cedar (Thuja plicata)-western hemlock (Tsuga heterophylla) in the Pacific northwest (Cassirer et al., 1996), and moorland in Iceland (Bengtson 1966).

Harlequin Duck nests are extremely well hidden and are usually placed on the ground close to streams but sites may be variable. Nests can be found on top of stable cutbanks, on side slopes of streams, on steep slopes (30-75°), in undercut streambanks, in cliff cavities above the stream, and in piles of woody debris (Bruner 1997, Hunt 1998, MacCallum and Bugera 1998) as well as in hollow trees and snags (Cassirer et al., 1993). Smith (2000c) reported the median horizontal distance from 25 nests in Banff Park to the nearest water as 1.03 m. The horizontal distance from 20 nests to water in the central Cascade Range of Oregon averaged 10.7 m (± SE = 3.0 m) while the vertical distance to water averaged 9.1 m (± SE = 3.0 m) (Bruner 1997). Nest sites are well concealed under overhead cover usually consisting of a shrub or small tree such as willow (Salix spp.), buffaloberry (Shepherdia canadensis), or Engelmann spruce (Picea Engelmannii) but sometimes under a log which was also concealed by vegetation (MacCallum and Bugera 1998). Smith (2000c) also reported nests concealed by cinquefoil (Potentilla fruticosa), Labrador tea (Ledum groenlandicum), white spruce (Picea glauca), subalpine fir (Abies lasiocarpa), common juniper (Juniperus communis) and deadfall. All nest sites whether found beside the stream or on top of a cut bank had excellent visibility for the incubating hen. Visibility for the incubating hen and the potential for escape may be an important factor for her survival in a linear system. Use of the same nest in consecutive years has been documented in Iceland, (Bengtson 1966) Oregon, (Bruner 1997) and the McLeod and Bow Rivers of Alberta (MacCallum and Bugera 1998, Smith 1999a).

Stream reaches that provide brood-rearing habitat in the McLeod River, Alberta are described by Allan et al. (1995) as dominated by riffle habitat bordered by overhanging vegetation (71% of the total area), and possessing the following characteristics: water channel largely unconfined with numerous bars, average wetted channel width 7.2 m and an average gradient of the reach 1.16%. Substrate was composed of cobble (49%), bedrock (20%), gravel (16%), boulder (13%) and fines (2%). In the McLeod River system, hens nested in these brood-rearing stretches but some also nested in smaller tributaries which were not used for brood-rearing after hatching (MacCallum and Bugera 1998). Smith (1998) also documented movement of broods from tributaries used solely for nesting, to brood-rearing habitat in the Bow River, Banff National Park.

CONSERVATION BIOLOGY

The Harlequin Duck is a small, short-billed duck that rides the surf easily. The bold patterning of the male in definitive alternate plumage is distinctive. It has slate blue body plumage, a darker head, chestnut flanks, a dark blue-brown belly, white scapulars, a metallic blue speculum, and white, black and chestnut stripes on the head, neck and chest. A white crescent in front of the eye and a white patch near the ear make identification of this bird unmistakable. Female body plumage is dark brown with a white belly, brown checks and three white patches on the head. Full descriptions of plumage characteristics are found in Farrand (1983), Godfrey (1986), Robertson and Goudie (1999) and Smith et al.

(1998). The significance of the male plumage with respect to pair formation is discussed by Cooke et al. (1997). Adult female harlequins are significantly lighter than adult male harlequins (Hunt 1998). Weight varies considerably over the year (Perfito 1998, Robertson and Goudie 1999). Smith (2000c) reports average mass for males on the Bow River as 604.89 ± 33.64 g and for females as 537.05 ± 41.62 g.

The Harlequin Duck is a river specialist nesting almost exclusively along swiftly flowing mountain streams. It is thought that the female generally returns to her natal stream (Bengtson 1972, Crowley 1994, Kuchel 1977, Wallen 1987) although Brown (1998) suggests that female natal philopatry[1] is imperfect and some dispersal of females to streams other than their natal streams exists. Long-term monogamous pair bonds are the norm for harlequins (Bengtson 1972, Brown 1998). Established pairs reunite on coastal winter grounds in fall (October to mid-December) and new pair bonds involving young males and females form in March, April and early May prior to migration inland (Gowans et al., 1997, Robertson et al., 1998a). Pairs arrive on the nesting rivers in Alberta in late April or early May (Alberta Environment 1999a, Hunt 1998, MacCallum et al., 1999, Smith 2000c).

Harlequin populations on the spring breeding range have a sex ratio generally skewed to males (Bengtson 1966, Cassirer and Groves 1991, Reichel et al., 1997). Smith (2000c) reported a long-term average of 1.76 m:1f (1995-1998) for the Bow River. Ratios were highest in the first two weeks in May and decreased as the pairs arrived. The male:female ratio during the prenesting survey for the McLeod River was reported as 1.1 m:1f (1996), 1.6 m:1f (1997), 1.4 m:1f (1998) and 1.1 m:1f (1999) (MacCallum 1997, MacCallum and Bugera 1998, MacCallum et al., 1999, MacCallum and Godsalve 2000). A significant proportion of females are non-breeders or failed breeders in any given year (mean in Iceland = 0.44; Bengtson 1972). In the McLeod River, 29% of females produced broods during the four years 1996-1999 (MacCallum and Godsalve 2000). In Banff, 39% and 40% of females produced young in 1997 and 1998, and in Kananaskis Country 23-28% of females produced young in the same two years (Smith 1999a). Similar to other seaducks i.e. Long-tailed Duck (Clangula hyemalis) and eiders (Somateria ssp.), female harlequins delay sexual maturation until their third year and more typically attempt to breed for the first time in their fourth breeding season (Perfito 1998).

The mean clutch size has been reported as 6.1 for 15 full clutches found in Banff and Kananaskis Country, 1996-1998 (C. Smith, pers. comm.) and 5.7 (range 3-9) in Iceland (Bengtson 1972). The egg-laying interval is 1.5 (Bruner 1997) or 2 days (Bengtson 1972). At the start of incubation, males migrate to the coast, eliminating the possibility of re-nesting (Goudie et al., 1994). Incubation lasts for 28 days (Bengtson 1972). The median date for incubation initiation ranged from 14 June to 18 June for the years 1997-1999 in Banff National Park (Smith 2000c); 3 June to 24 June for the years 1997-1999 in Kananaskis Country (Smith 1997, 1999b, 2000b); and 13 June to 28 June for the years 1996-1999 on the McLeod River (MacCallum and Godsalve 2000). Mean hatch dates for the Maligne River in Jasper National Park ranged between 15 July to 4 August for the years 1993-1995. Hatching occurred later at higher elevations (Hunt 1998). Mean hatch dates for the McLeod River ranged between 11 July to 25 July for the years 1996-

[1] Natal philopatry refers to the return to an area of birth or hatching by first-time breeders (Anderson et al., 1992)

1999 (MacCallum and Godsalve 2000). Mean hatch dates for Banff National Park ranged from 12 July to 16 July for the years 1997-1999 (Smith 2000c) and 30 June to 22 July for the years 1997-1999 in Kananaskis Country (Smith 1997, 1999b, 2000a).

Bengtson (1966) concluded that the availability of suitable food seemed to be the most important factor controlling distribution and breeding frequency of the Harlequin Duck. Streams used by Harlequin Ducks in Labrador when compared to unused streams had greater overall numbers of invertebrates (Rodway 1998a). Hunt (1998) found there was a significant positive correlation between the mean quantity of benthic macroinvertebrate prey and mean daily abundance of harlequins at the Maligne Lake Outlet in Jasper National Park.

The Harlequin Duck is a long-lived bird with low productivity. Population models indicate that adult survival appears to be the main factor influencing population stability for sea ducks. This suggests little can be achieved through management of biological parameters such as survival and production of young (Goudie et al., 1994). Local survival rates for adult males and all age females have been reported as 82% and 76% respectively from wintering ground studies at White Rock, British Columbia. (Cooke et al., 2000). Survival rates of paired males were higher (91%) and unpaired and unknown status males were lower (70%). Smith (2000b) reported survival rates for males and females on the Bow River as 81% and 71% respectively. Adult survival remained relatively constant throughout the five year Bow River study.

Harlequin ducklings fledge at 52 days (Bruner 1997) although extensive variations in fledging times have been observed (Bengtson 1972, Cassirer et al., 1996, Kuchel 1977, Wallen 1987). Duckling survival from hatching to fledging was 60% for 13 broods in the Cascade Mountains, Oregon (Bruner 1997). This is a greater survival rate than found in various other waterfowl species (Leonard et al., 1996). Brood mortality was highest in the first two weeks. Juvenile survival to fledging varied from 18% to 83% in a three year study in Montana, with all chick mortality occurring in the first three weeks following hatching (Kuchel 1977). The survival of ducklings from newly hatched to full-grown for three rivers in Iceland varied from 40% to 76% over a period of five years (Bengtson 1972). MacCallum et al. (1999) estimating duckling survival from hatching to fledging on the McLeod River in 1997 and 1998 as 72%. Smith (2000b) estimated the 1997 and 1998 prefledging survival in Banff and Kananaskis Country as 27%; postfledging survival of ducklings fitted with internal and external radios as 42.9%; and overall survival from hatching to migration as 11.5%. It is unknown if internal radios adversely affect duckling survival; if so, then the postfledging estimates would be biased low. Wide annual variation in duckling survival rates has been reported for other duck species (Leonard et al., 1996).

Systematic surveying and mapping of the distribution of the Harlequin Duck in its breeding range indicates that harlequins use a river system variably through the spring and summer season and will spatially redistribute themselves depending on season and reproductive phenology (Bighorn 1996, MacCallum 1997, MacCallum and Bugera 1998). Pre-nesting pair locations are not necessarily proximate to nest locations or to brood-rearing stretches. A study of eight paired females in the McLeod River system indicated that on average hens in the pre-nesting period were captured 8.6 km (range 1.2 - 16.8 km) from their nest location. Broods have been documented swimming up and downstream

soon after hatching either to reach favoured brood-rearing stretches (MacCallum 1997) or as a response to flooding which temporarily washed them downstream to unsuitable habitat (MacCallum and Bugera 1998). The Harlequin Duck can walk or run on land without any difficulty even for quite long distances (Bengtson 1966). Evidence of a hen travelling overland with a young brood has been documented by Hunt (1998) and MacCallum and Bugera (1998). By mid-August broods were observed moving extensively throughout the McLeod River system and were often found in areas which they had not used as a young brood (MacCallum 1997).

Moulting takes place when the birds return to the coast from their inland breeding grounds. Males from Alberta return to the coast from late June to mid-July. Non-breeding or unsuccessful females stage for migration to the coast in late July (MacCallum 1997, MacCallum and Bugera 1998) through to mid-August (C. Smith, pers. comm.). Females with broods return to the coast from early September through to mid-October (Hunt 1998, MacCallum and Bugera 1998, MacCallum et al., 1999, Smith 2000c). The young of the year remain on the coast for their first and second winters, and generally return inland in their second spring as third year birds. It is believed that harlequins do not migrate in large congregations and that their migration is non-stop or very quick (MacCallum 1997, MacCallum et al., 1999, Smith 1999b). In 1998, a non-breeding female was observed on the McLeod River in Alberta at 14:10, 31 July 1998 (B. Godsalve) and was subsequently recorded at White Rock, British Columbia at 8:00 a.m, 2 August 1998 (F. Cooke). There are few inland records of harlequins during migration.

Harlequins exhibit a high degree of fidelity to specific wintering areas. Many Harlequin Ducks moult and over-winter at the same location, an uncommon trait among waterfowl (Robertson et al., 1998b). Young males and unpaired adult males are known to disperse from over-winter locations indicating considerable gene flow between populations (Cooke et al., 2000). Banding programs in both Alberta and British Columbia have confirmed that birds breeding in Alberta, winter along the Pacific coast from Seattle, Washington, through the Straight of Georgia and as far north as the Queen Charlotte Islands. They also winter on various locations on the west coast of Vancouver Island (MacCallum 1997, MacCallum and Bugera 1998, Smith 2000a, 2000c).

DISTRIBUTION

1. Alberta - Historical (prior to 1986) and recent records of the Harlequin Duck in Alberta have been compiled by Alberta Environment (1999a) and incorporated into the Biodiversity/ Species Observation Database. Sources for the database include records from: five museums (Canadian Museum of Nature, Alberta Provincial Museum, University of Alberta Zoology Museum, University of Calgary Zoology Museum, Banff Museum); CanSIS; Alberta Natural Heritage Information Centre; Jasper, Banff and Waterton National Parks data files; recent Canadian Wildlife Service/Alberta Environment air and foot surveys (Allen 1998, Canadian Wildlife Service, unpubl. data, Clark 2000, Hobson 1997, Gregoire et al., in prep., Norstrom 1998); detailed studies on the Maligne River (Hunt 1998), the Bow River (Smith 2000c), the Elbow, Kananaskis, Sheep and Highwood Rivers (Smith 1996, 1998, 1999b, 2000a), and the McLeod River (Bighorn 1996, MacCallum 1997, MacCallum and Bugera 1998, MacCallum et al., 1999). Personal observations were solicited from 18 individuals who contributed records to the Alberta Breeding Bird Atlas between 1987 and

1991 (Semenchuk 1992); and 23 individuals with historic and current information. Records were extracted from 43 published and unpublished reports including publications such as *Alberta Bird Record*, *Pica*, and *Alberta Naturalist*. A summary of the 3796 records in BSOD as well as additional records, is found in Appendix 2 and is organized north to south by watershed (Smoky, Athabasca, North Saskatchewan, Red Deer, Bow and Oldman Rivers).

Harlequin Duck breeding range in Alberta is restricted to a 53 000 km^2 area of the east slope and mountainous portions of the province from Waterton Lakes National Park in the south, north of the Kakwa Wildland Park (Figure 1). Within their breeding range harlequins occupy streams and rivers that possess suitable habitat characteristics. Harlequins have been reported on 177 rivers and streams and 56 lakes and ponds within their breeding range in Alberta (Appendix 2). Breeding has been confirmed on 76 rivers and streams, is probable on 25, unknown on 72, and unlikely on four. Breeding has been confirmed for 10 lakes within harlequin breeding range, is probable on one, unknown on 21, and unlikely on 24. Outside their breeding range, the Harlequin Duck has been observed on four rivers and nine lakes. The Harlequin Duck is known to breed on the streams draining the Canadian Shield in the Northwest Territories adjacent to Alberta's northern boundary. It is possible that harlequins breed in the Kazan Upland located in the extreme northeast corner of Alberta (Strong 1992) but this is completely speculative at this time.

Forty-nine percent of the breeding range of the Harlequin Duck in Alberta falls within protected areas - Waterton Lakes, Banff and Jasper National Parks, Peter Lougheed, Bow Valley and Switzer Provincial Parks, the Willmore Wilderness Park, the Ghost, Siffleur and White Goat Wilderness Areas, the Bob Creek, Elbow-Sheep, Bow Valley, Whitehorse and Kakwa Wildland Parks and several Natural Areas and Ecological Reserves (Alberta Environmental Protection 1999a). As well, a number of areas with development or use restrictions also lie within harlequin breeding range i.e., the Castle Access Management Area, Kananaskis Country, and the Panther Corners, Upper Clearwater River, Job Lake and Blackstone/Wapiabi Forest Land Use Zones (Alberta Forestry, Lands and Wildlife undated).

1.1 Smoky River watershed - Harlequin Duck breeding range in this watershed covers 7500 km^2, of which 66% falls within protected areas. Much of the Smoky River watershed is inaccessible except for foot and horse traffic. Historical but not recent records exist for the Narraway River, Nose Creek and Two Lakes (Soper 1947). The current breeding status for these waterbodies is unknown. Systematic surveys of selected streams in the Smoky watershed began in 1997. Harlequins have been confirmed to be breeding on the Muskeg, Sulphur, South Sulphur and West Sulphur Rivers. Breeding is probable on Sheep, Cote, Hardscrabble and Lick Creeks and the Muddywater, Smoky and Torrens Rivers. Harlequins have recently been observed (unknown breeding status) on eight additional rivers and creeks and one lake (Appendix 2).

1.2 Athabasca River watershed - Harlequin Duck breeding range in the Athabasca watershed comprises 14 400 km^2, 73% of which is found within protected areas. Historical but not recent records exist for Fryatt, Osborne, Simla, and Simon Creeks, an unnamed tributary to Snake Indian River, Willow Creek, Amethyst, Cavell and Edna Lakes. Many of these waterbodies have not been surveyed since the Banff/Jasper biophysical (Holroyd and VanTighem 1983). An August 30, 1917 collection record of a

Figure 1. Harlequin Duck distribution in Alberta.

female and male duckling by W. Spreadborough on Cavell Lake, Jasper National Park is the earliest record for this watershed (Canadian Museum of Nature). Observation data is the only information source for several other waterbodies in this watershed e.g. Mowitch Creek, Rock Creek, Snake Indian River, Rocky River, Medicine Tent River, Whirlpool River, Lick Creek, Sunwapta River and Poboktan Creek. There are no records for the Snaring River and tributaries. It is unknown if this is because of unsuitable habitat, or absence of survey effort. Some lakes at the headwaters of streams are used by broods during brood-rearing season (Maligne, Medicine, Jacques). High elevation lakes like the Maligne may act as catchment basins for glacial silt thus increasing water clarity for streams draining these lakes (Hunt 1998). Harlequins have recently been observed on 62 rivers and creeks and 21 lakes and ponds in this watershed. Breeding has been confirmed on 29 rivers and creeks and two lakes, is probable on nine streams, unknown on 21 streams and seven lakes, and unlikely on three streams and 12 lakes (Appendix 2).

1.3 North Saskatchewan River watershed - Very little information exists for this watershed despite the presence of a number of streams with potential harlequin habitat. The total area of harlequin range within the North Saskatchewan watershed is 12 100 km^2 of which 36% falls within protected areas. Historical but not recent records exist for the Cairn River, the North Saskatchewan River at Windy Point in 1949 prior to construction of the Bighorn Dam, Arctomys, Dolomite, Rampart and Ruby Creeks and Glacier, Warden and Waterfowl Lakes. Many of these waterbodies are infrequently visited. Harlequins have recently been observed on 28 rivers and creeks, and six lakes in the North Saskatchewan watershed. Breeding has been confirmed on eight streams in this watershed; is probable on six streams, unknown on 14 streams and four lakes, and unlikely on Warden and Waterfowl Lakes. Harlequins are regularly observed on Brazeau and Southesk Lakes during breeding season (Hunt and Clarkson 1994).

1.4 Red Deer watershed - The Red Deer River and its tributaries are part of the South Saskatchewan watershed. Headwaters of the Red Deer River basin originate in Banff National Park but do not extend to the continental divide. Harlequin Duck breeding range in the Red Deer River watershed covers approximately 3200 km^2; 32% of which falls within Banff National Park. All harlequin records in the Red Deer watershed were made recently on or after 1986 with the exception of the Panther River for which historical and recent records exist. Harlequin Ducks have been observed on 10 rivers and creeks and two lakes in the Red Deer watershed. Harlequins are confirmed to be breeding on four streams and one lake: Divide Creek, Dormer River, Scotch Camp Creek, Snowflake Creek and an unnamed cirque north of Harrison Lake. Wigmore Creek and Harrison Lake are identified as probable breeding. The breeding status of five streams is unknown: Burnt Timber Creek, Little Red Deer River, North Burnt Timber Creek, Red Deer River and the Panther River. Knowledge of harlequin numbers and distribution in the Red Deer River watershed remains incomplete.

1.5 Bow River watershed - Harlequin Duck breeding range comprises 10 200 km^2 in the Bow River watershed of which 52% falls within protected areas. Historical but not recent records exist for Altrude, Cliff, Dyson, Gorge, and Stoney Creeks, and Owl, Sawback, and Vermillion Lakes. A female harlequin taken in 1891 from Banff National Park is the earliest record for this watershed (Canadian Museum of Nature). Systematic work has been

conducted on the Bow River and various streams in Kananaskis Country in the Bow watershed since 1995. Eighty-one harlequins were observed on 15 May 1997 on the Bow River between Outlet Creek and Castle Junction identifying this stretch as an important spring staging area. In Kananaskis Country, the Harlequin Duck has been described as an uncommon to fairly common summer resident and breeding bird (Wisely 1979). It breeds regularly along the Sheep River and major tributaries, along the Highwood River, the Elbow River, the Kananskis River valley and in other drainages where its favoured habitat, swift and clear mountain rivers are found. Harlequins have been observed on 40 rivers and streams and 21 lakes in the Bow River watershed (Appendix 2). In the Bow River watershed, breeding has been confirmed on 23 streams and seven lakes, is probable on one stream, and is unknown on 15 streams and four lakes. Breeding is unlikely on Two Jack Canal and Lake Minnewanka, Lorette Ponds, Barrier, Johnston, Lower Kananaskis, Smith, Taylor, Two Jack, Upper Kananaskis and Vermillion Lakes. Headwater lakes that are used by broods are: Annette, Haiduk, Hector, Marvel, Moraine, and Spray Lakes Reservoir. A number of streams which may possess habitat suitable for nesting have no records e.g. Ghost River.

1.6 Oldman River watershed - Harlequin breeding range in the Oldman River watershed closely borders British Columbia and comprises 5600 km^2. Sixteen percent of harlequin range in this watershed falls within protected areas. Access is good throughout the Oldman River watershed and angling activity begins early in the season on the May long weekend. Historical but not recent records of harlequins exist for the Crowsnest Creeks and Cameron, Crowsnest, Little Crypt and Lower Waterton Lakes. The earliest record from the Oldman River watershed is of a specimen collected by Coues in 1874 from Waterton Lakes National Park (Canadian Museum of Nature). An unconfirmed report of 80 females and immatures reported for Knights Lake in Waterton National Park 23 October 1966 (Sharp 1973) may have been an observation of Long-tailed Duck (Clangula hyemalis), Scoters (Melanitta spp.) or other migrating waterfowl (K. VanTighem, pers. comm.). Recent records indicate breeding on eight streams in this watershed (Blakiston Creek, Carbondale River, Castle River, Lynx Creek, North Belly River, Oldman River, Racehorse Creek and West Castle River). Breeding is probable on the Livingstone River and unknown on six streams: Cameron, Crowsnest, Pincher, Rowe and Yarrow Creeks and the Waterton Rivers. Five lakes in the Oldman River watershed were classified as unknown breeding status (Cameron, Crowsnest, Little Crypt, Lower and Upper Waterton). Sharp (1973) reported that the Harlequin Duck breeds in Waterton Lakes National Park in moderate numbers. It is unknown whether the harlequin population has changed since 1973 but current records indicate the population is sparse. Inventory of selected streams has been initiated recently in Waterton Lakes National Park and in the adjacent foothills by Alberta Environment.

1.7 Records outside breeding range - Harlequins have been recorded elsewhere in the province during fall migration at Cold Lake and Lac La Biche (Alberta Environment 1999a, Sherrington 1994), and Little Fish Lake (Schowalter 1994), and during spring migration at Beaverhill Lake (Pinel et al., 1991, Sherrington 1996), Gregoire Lake (Pinel et al., 1991), and Lake Newell (E. Jones, pers. comm.). Winter records have been documented at Cold Lake (Alberta Environment 1999a, Klauke 1989), Goldbar Park in Edmonton (E. Jones, pers. comm.) and various locations in Calgary (Lang 1973, Pinel et al., 1991). Historical records exist for

Cooking Lake and Fleming Lake in the Caribou Mountains (Salt and Salt 1976), the Muskeg River north of Ft. McKay (Francis and Lumbis 1979), and in Wood Buffalo National Park where a few have been reported to winter on the Little Buffalo River (Salt and Salt 1976).

2. Other Areas - Current distribution in North America (Figure 2) reflects differences from a similar map published by Palmer (1976). Some differences are a result of better inventory and record keeping and known breeding range has been expanded e.g., Northwest Territories, northern Quebec and Labrador. Other differences indicate a loss of range in insular Newfoundland and California. Recent surveys indicate a number of streams located in the U.S. Rocky Mountains are no longer being used by harlequins indicating a possible contraction of breeding range.

Two Harlequin Duck populations are found in North America, the western population is found along the Pacific Coast and the eastern population found on the Atlantic coast (Figure 2). The western population breeds in Alaska, Yukon, Northwest Territories, British Columbia, Alberta, Washington, Oregon, Montana, Idaho, and Wyoming. Western birds winter on the Pacific coast from the Aleutian Islands in Alaska, to northern California. Eastern populations breed in Labrador, northern Quebec, the Gaspe Peninsula, Newfoundland, and northern New Brunswick. Eastern harlequins winter in Greenland, Newfoundland, Nova Scotia, New Brunswick, Maine and as far south as Virginia. It is now believed that there are two wintering populations in eastern North America. Birds nesting in northern Quebec and Labrador are known to undertake a moult migration to southwestern Greenland where they also winter. Harlequins wintering in the Maritimes and the New England States (primarily Maine) are found nesting in Labrador (below 57°N), Newfoundland, Gaspe, New Brunswick, and Maine.

Harlequins breed all through southern Alaska, north to the Yukon River and Brooks Range, and west to the Seward Peninsula and along the Alaska Peninsula (Robertson and Goudie 1999). Distribution in the Northwest Territories is widespread. Breeding has been confirmed in the Mackenzie Mountains within the Tundra Cordillera Ecozone (Wiken 1986), and in the fast flowing rivers along the edge of the Precambrian Shield (Fournier and Bromley 1996). Evidence suggests that the Northwest Territories population may number in the hundreds of breeding pairs although the actual population is unknown and may be much less (M. Fournier, pers. comm.). Harlequins have been observed throughout the Yukon although there have been only 11 records of broods in the past 20 years (P. Sinclair and C. Smith, pers. comm.).

In British Columbia, breeding records exist for coastal and inland British Columbia from sea level to 2175 m including Vancouver Island, Queen Charlotte Islands, southern and central interior, western slope of Rockies, and the upper portions of the Peace River drainage (Breault and Savard 1991). In winter, harlequins are found throughout coastal British Columbia where they tend to be highly gregarious during the non-breeding season. Mid-March concentrations of 4000 to 5000 harlequins have been documented in the Strait of Georgia when harlequins and other sea birds feed on herring roe during spawning. In Washington, harlequins breed in the Olympic and Cascade Mountain Ranges and in the extreme northeast. Wintering occurs in northern Puget Sound, northern Hood Canal, Strait of Juan de Fuca, San Juan Islands, and the outer coast. In Oregon, harlequins breed in the west slopes of the Cascade Mountains, and in the north central coast range where they

Figure 2. Harlequin Duck distribution in North America and Greenland.

are present from April to the end of August. Comparison of the former range with the present range indicates considerable northward contraction and holes in the current distribution (R. Jarvis, pers. comm.). Harlequin Ducks winter on the Oregon coast and in northern California where they are also identified as possibly breeding in one stream (Cassirer et al., 1996).

The Harlequin Duck is known to breed in 57 breeding or probable breeding occurrences represented by 118 streams in the U.S. Rocky Mountains (Montana, Idaho, Wyoming). Incidental records of harlequins have been made for an additional 78 streams in the U.S. Rocky Mountains (Cassirer et al., 1996). Reductions in distribution have been documented primarily in the eastern and southern parts of the range in the U.S. Rocky Mountains. Reichel et al. (1997) listed seven streams in Montana, four in Idaho, and one in Wyoming which appear to be no longer used by harlequins which previously had a record of use as recently as 1987. Harlequins are thought to have bred historically in Colorado, probably as a small isolated population at least until 1883 (Parkes and Nelson 1976).

POPULATION SIZE AND TRENDS

1. Alberta - Thirty-nine Harlequin Duck breeding occurrences have been identified in Alberta in 1999 (Alberta Natural Heritage Information Centre). The Bow River is the only breeding occurrence in Alberta with 40 to 99 pairs. There are six occurrences in the Smoky, five in the Athabasca, two in the North Saskatchewan, one in the Bow and one in the Oldman watershed with 20 to 39 pairs. There is one population in the Smoky, seven in the Athabasca, four in the North Saskatchewan, two in the Red Deer, four in the Bow and one in the Oldman watershed with 3 to 19 pairs. Four systems (one in the Athabasca, one in the North Saskatchewan and two in the Oldman) are known to have one to two pairs. There are eight additional systems in Alberta which are identified as potential breeding occurrences.

Of the 39 breeding occurrences, 4 (10%) were ranked using a population estimator, 5 (13%) were ranked using foot survey information, 13 (33%) were ranked using air survey information, and 17 (44%) were ranked using incidental observations. Air and foot survey results were adjusted with visibility ratios published in Gregoire (2000) and MacCallum (2000) respectively.

Based on banding effort, Hunt (1998) calculated that there were 29, 41, and 61 adult harlequins for 1993-1995 respectively in the Maligne Valley. Population estimates using mark-resighting estimators over a period of four, five and four years respectively for the Elbow, Bow and McLeod Rivers in Alberta indicate populations in these localities are stable (Smith 2000a Smith 2000c, MacCallum and Godsalve 2000). The 1999 estimate for the Elbow River of 27 ± 7.6 (S.D.) adult harlequins falls within the range of estimates since 1996 (Smith 2000a). There was no difference in the population estimates for the Bow River between 1995 and 1999 so the data was pooled for a median annual estimate of 153 adults (Smith 2000c). The 1999 population estimate for adult harlequins on the McLeod River was 68 ± 2 (S.D.) which falls within the range of estimates since 1996 (MacCallum and Godsalve 2000).

No population estimate of breeding harlequins in Alberta is available but based on existing knowledge and known estimates for local watersheds (Appendix 2), a preliminary projection of the minimum population of harlequins breeding in Alberta is 1600 to 4000. Given that systematic survey of selected streams for Harlequin Duck presence and

abundance has only recently been initiated in Alberta, an assessment of population trend by comparing historical to recent observations is not possible.

2. Other Areas - The Harlequin Duck is found in four distinct, low arctic populations that occur in the Pacific, Greenland, Iceland and eastern North America. The largest population is found in the Pacific (Asia and northwestern North America). On wintering grounds, Goudie et al. (1994) estimated that there were 165 000 harlequins in the North Pacific Rim of Canada and the United States of America and possibly an additional 50 000 to 100 000 birds in Russia's North Pacific Rim. Robertson and Goudie (1999) reported 18 000 wintering in Prince William Sound, Alaska, and 11 000 to 15 000 in the Strait of Georgia which represents a portion of the birds wintering in coastal British Columbia. A population estimate for the Strait of Juan de Fuca and Puget Sound in Washington State for 1995 was 3,031 ± 395 harlequins (Schirato and Hardin 1998). Overall population demographics based on banding, recaptures, re-observations and aerial surveys from 1991 to 1997 suggest a stable to increasing population in Washington. The Oregon population is roughly estimated at 50 to 100 pairs (R. Jarvis, pers comm.). Approximately 300 pairs of harlequins are known to breed in Montana, Idaho and Wyoming (Cassirer et al., 1996).

The historical population of the Harlequin Duck in eastern North America was estimated at 5000 to 10 000 individuals by Goudie (1989). In 1995, Montevecchi et al. (1995) estimated the current population had dropped to about 1000 individuals. Hunting mortality may have been the main factor responsible for the population decline (Goudie 1989, Palmer 1976, Philips 1925). Recent work in Maine and Rhode Island indicates that the eastern population has been recovering in some areas, especially in the southern part of the winter range (Goudie et al., 1998). As well, local populations in Newfoundland and elsewhere in eastern North America have been increasing rapidly in the past few years (Goudie et al., 1998). Increasing numbers indicate that the population was historically larger and is not limited by the available habitat. Harlequin Duck breeding in Gaspe and northern Quebec make long moult migrations to Labrador and even as far as Greenland. These observations have helped to rationalize some of the sightings of larger than expected numbers of adults on rivers in northern Quebec and post breeding aggregations in Northern Labrador (Goudie et al., 1998). The current minimum estimate of Harlequin Ducks wintering in eastern North America is 1200 to 1400 birds (D. Amirault, pers. comm.) plus about 2000 to 3000 wintering in western Greenland. It is unknown what proportion of the ducks breeding in northern Labrador comprise the wintering population in Greenland. Icelandic and Greenlandic populations have declined this century to about 5000 pairs each (Montevecchi et al., 1995).

LIMITING FACTORS

This section discusses potential limiting factors which may make the Harlequin Duck vulnerable to natural and human-induced disturbances that may degrade habitat suitability, reduce survivorship of young or adults, or decrease nesting success by adults.

The Harlequin Duck is most vulnerable to human-induced disturbances on wintering grounds where they may be clustered together in groups of hundreds or thousands within a small area e.g., on 24 March, 1989 the Exxon Valdez oil spill damaged Harlequin Duck populations wintering in Prince William Sound, Alaska (Murphy et al., 1997, Piatt et al., 1990). The Harlequin Duck is known to

be relatively tame compared to other sea duck species (Palmer 1976) and in coastal habitats they forage in shallow waters close to shore, perhaps resulting in a vulnerability to hunting. Goudie (1991) referred to historical hunting as an important factor contributing to the decline of Harlequin Ducks on the east coast of North America and concluded that historical and more recent evidence was sufficiently strong to support that hunter harvest of Harlequin Ducks in eastern Canada (prior to listing by COSEWIC in 1990) had been of sufficient magnitude to cause the rate of mortality to exceed the rate of recruitment. Hunting for Harlequin Ducks occurs along coastal wintering grounds in Oregon and Washington. Special hunting restrictions have been instituted in Washington to regulate this harvest (G. Schirato, pers. comm.). Waterfowl hunting also occurs on the coast of British Columbia, but on most years Harlequin Duck wings are not detected in the National Harvest Survey (Canadian Wildlife Service). Harlequin Ducks generally migrate to the coast prior to waterfowl hunting season in Alberta (see below).

Harlequin Duck distribution in their breeding range is limited by relatively narrow habitat requirements. In Alberta, breeding is restricted to the mountains and eastern slopes although they are widespread within this range where suitable habitat exists. Bengtson and Ulfstrand (1971) linked Harlequin Duck productivity and habitat selection to macroinvertebrate density. Productivity may be influenced by food availability and periodic low food abundance may result in extensive non-breeding thus affecting recruitment rate (Bengtson 1972). Wright et al. (2000) documented reduced numbers of harlequins, delay in brood development and a decrease in abundance of the primary food item after a severe flood on Quartzville Creek, Oregon. Catastrophic drift of invertebrates caused by periodic natural slumping is thought to reduce the foraging value of Prospect Creek, Alberta for harlequins (MacCallum and Godsalve 2000). A probable shortage of food caused by extremely high water causing substrate or habitat washout has been described on MacDonald Creek, Montana by Kuchel (1977). In general, streams used by Harlequin Duck have relatively low mean benthic animal standing crops and low productivity (Bengtson and Ulfstrand 1971, Hunt 1998, Rodway 1998b). It has been suggested that populations are food-limited on the breeding grounds, and that river specialists like the Harlequin Duck may be subjected to greater energy constraints on foraging effort than dabbling or other diving waterfowl (Rodway 1998b).

The effect of human disturbance on harlequins is poorly understood. Studies of social behaviour and especially potential costs and benefits of social behaviours are lacking for harlequins and other duck species (Brown 1998, Leonard et al., 1996). It is generally believed that harlequins are sensitive to activities that are concentrated on the shoreline such as hiking, fishing, camping or other activities that may result in the destruction of nests, disturbance of incubating hens or disturbance of the downy broods. Human activity on a boardwalk installed as a fish-viewing area in Yellowstone National Park was thought to be disturbing breeding harlequins. Management actions were implemented to reduce visitorship and institute timing restrictions (T. McEneaney, pers.comm.). Hunt (1998) documented depressed foraging patterns of adult harlequins when disturbed by rafting at the Maligne Lake Outlet in Jasper National Park. Analysis of the reactions of flocks to watercraft in the Maligne Lake Outlet indicated that 59.7% of flocks reacted by flying, 21.7% by swimming, 6.1% by scooting, 5.7% displayed alert behaviour but were not displaced, and 6.8% showed no response (Hunt

1998). Smith (2000c) recorded a lower incidence of reaction by Harlequin Ducks to canoes in the Bow River during instream surveys 1995-1999 (17.4% swimming away, 13.6% flying, 11.8% hiding, 42.8% no response).

In certain circumstances, harlequins show tolerance to activities conducted on shore e.g. Quartzville Creek supports the largest harlequin breeding population in Oregon as well as providing a variety of outdoor recreational activities including gold mining, camping, fishing and viewing wildlife (Wright et al., 2000). MacCallum and Bugera (1998) documented movement of newly hatched broods from secluded side streams into prime brood-rearing stretches of the McLeod River which were subjected to dispersed camping, low to moderate levels of fishing along the shore, and road traffic. Harlequin Ducks appear to modify their response to unpredictable events in their environment depending on their sex, the time of year, and possibly their stage within the breeding season (Perfito 1998). The magnitude of the stress response is further modified by body condition.

Habitat for Harlequin Ducks can be degraded or modified by altering streambank or channel characteristics, influencing water yield levels, and reducing water quality through increased sedimentation (Cassirer et al., 1996). Activities such as stream channelization, damming, brush removal, gravel extraction, dredging, bank rip-rap and road construction can influence habitat quality for Harlequin Ducks. A large proportion of Albertas breeding population is located in national and provincial parks and provincial wildlands thereby reducing the potential impact of industrial activity and development. Forest harvest activity generally is not associated with subalpine habitats and occurs on the eastern edge of harlequin range in the northern east slope of Alberta (Alberta Environment 1999b). In the southern east slope, (i.e. Oldman River drainage) allocations for timber harvest occur within harlequin range. Mining in the foothills of Alberta occurs near Grande Cache, the Coal Branch area south of Hinton and east of Canmore. Historically, coal mining occurred in the Crowsnest Pass and other areas of the Alberta foothills. Cattle grazing may occur in harlequin habitat in southern Alberta, although the extent to which this activity overlaps with streams occupied by the Harlequin Duck is unknown.

STATUS DESIGNATIONS

*1. **Alberta*** - The Harlequin Duck is currently ranked 'sensitive' in the province according to the *Status of Alberta Wild Species* 2000 (in prep). Harlequins were moved from the Green list in 1991 to the Yellow A list in 1996 (See Appendix 1 for status definitions). Species are listed sensitive when there has been concern expressed over long-term declines in their numbers. Naturalist records of the Harlequin Duck in Alberta indicated a decline in the Jasper and Banff areas, possible conflicts with recreation activities had been identified, the population was unknown and restricted in distribution, and population declines in neighbouring jurisdictions were identified (Alberta Wildlife Management Division 1996). The Alberta Natural Heritage Information Centre has assigned a rank of S3 to breeding Harlequin Ducks and S1 to non-breeding ducks in the province (ANHIC 2001).

*2. **Other Areas*** - In April 1990, the Committee on the Status of Endangered Wildlife in Canada designated the eastern North American population of Harlequin Duck as 'endangered' (COSEWIC 2001). Declines from historic population levels to levels considered to be below minimum viable population size were cited as the reason for listing this species

(Montevecchi et al.,1995). The eastern North American population of Harlequin Duck is not protected by the U.S. Endangered Species Act because, although the current population is probably lower than it was historically, it is gradually increasing. As well, factors such as hunting and oil spill damage that may have contributed to the species original decline, have been controlled or reduced (Lambertson 1998). Western populations of Harlequin Duck are not on the COSEWIC list meaning they are not considered to be vulnerable, threatened, or endangered. Although, several agencies in North America have identified the western population of Harlequin Duck to be of special management concern (Cassirer et al., 1996).

The Global Heritage Status Rank of the Harlequin Duck is G4 (Nature Serve 2000; see Appendix 1 for definitions). The Harlequin Duck is on the 'Yellow List' in British Columbia which means the species is not considered at risk, but is still on the tracking list of species which are vulnerable during times of seasonal concentration (BC Conservation Data Centre 2000). Its conservation status in British Columbia is S4B (breeding), S3N (non-breeding), in Washington S3, in Oregon S2B, S3N, in Idaho S1B, SZN, in Wyoming S1B, SZ?N, and in Montana is S2B, S3N (NatureServe 2000). The conservation status for Alaska, which may have the largest population of Harlequin Ducks in North America, is S3S4B and S3S4N.

RECENT MANAGEMENT IN ALBERTA

The Harlequin Duck is classified as a migratory game bird in Alberta as elsewhere in western North America. Bag limits in Alberta are eight per day. Hunting for ducks, coots and snipe in the mountain Wildlife Management Units (400 series) and the two foothill units 316 and 318 which comprise Bird Game Zone eight, is open 1 September to 16 December (Alberta Environmental Protection 1999b). Harlequin females with broods are present in Alberta until as late as early October, however waterfowl hunting is generally focussed on the prairie and parkland Wildlife Management Units (100 and 200 series), as well as selected boreal (500 series) and foothill units (300 series) outside harlequin range.

Permanent year-round closure of the mid-Maligne River in Jasper National Park to all watercraft use was instituted in the 1999 operating season after a review concluded that the security of the Harlequin Duck during prenesting, nesting and brood-rearing phases could not be assured on the basis of current scientific knowledge (Hooper 1998). Previous to the closure, timing restrictions on boating on the mid-Maligne River and on the land surrounding the Maligne Lake Outlet had been initiated in 1993 in an attempt to reduce the effects of rafts and disturbance from shore on the feeding behaviour of courting pairs in May and June (Hunt 1998). To address concerns regarding potential effects of watercraft on breeding and incubating harlequins and their broods, Alberta Natural Resources Service implemented limits on the number of commercial rafting operations and introduced seasonal and daily timing restrictions for commercial rafting activity on portions of the Elbow, Sheep and Highwood Rivers in 1999 (J. Jorgenson, pers. comm.).

A specific mitigation and monitoring program has been developed to reduce the potential effects of mining on Harlequin Duck in the McLeod River system. The program involves detailed study to understand Harlequin Duck use of the area to be impacted, reduction of impacts during the construction phase, reduction of impacts during the mining phases including disturbance levels in riparian areas,

implementation of stream restoration/ enhancement activities, development of a long-term monitoring program, and participation in cooperative regional studies (Cardinal River Coals Ltd. 1999).

Recent research and applied field studies in Alberta has provided insight into population characteristics, habitat requirements, movement patterns, migration, and response to recreational disturbance (Hunt 1998, MacCallum and Godsalve 2000, Smith 2000a, 2000b, 2000c). A Foothills Model Forest program was initiated in 1999 to provide a regional context for abundance, distribution and habitat sensitivities relating to Harlequin Ducks in the northern Rocky Mountains and foothills of Alberta. A cumulative effects assessment was conducted for the McLeod River watershed (Bighorn 1999). Extensive research is being conducted on various aspects of the ecology of wintering populations in coastal British Columbia through a collaboration between Canadian Wildlife Service, and the Chair of Wildlife Ecology at Simon Fraser University.

SYNTHESIS

The Harlequin Duck is a long-lived species possessing characteristics which could potentially make them vulnerable to human-induced disturbance. A Lack of information on the biology of the Harlequin Duck and specifically information on their abundance and distribution in Alberta has hampered the understanding of this species and its status in the province. Regional inventories initiated by various agencies in the 1990's have begun to provide an understanding of distribution and occurrence of the Harlequin Duck throughout its range in Alberta. The results of these inventories are being used in conjunction with habitat and land-use information to increase knowledge of harlequin distribution and population, and to further refine the understanding of environmental limiting factors and potential human impacts.

Breeding range for the Harlequin Duck in Alberta is restricted to the southwest corner of the province and is associated with alpine and subalpine environments. A large percentage of harlequin range in Alberta (49%) is found in areas which are formally protected by legislation i.e. National Parks, Provincial Parks and Provincial Wildlands. A preliminary estimate of the harlequin population in Alberta is 1600 to 4000. Population trend data is sparse but where it exists, stable populations are indicated. Distribution gaps appear to occur in the Snaring River area of Jasper, the Ghost River area of the Bow watershed and the Crowsnest area of the Oldman watershed. This may be because of habitat restrictions or a lack of observation rather than a lack of ducks.

Management of human-induced disturbances in Alberta has focussed on the development of site specific mitigation for rafting concerns on a number of streams in Alberta, development of site specific mitigation for potential mining impacts, and monitoring of specific population responses. Waterfowl hunting generally occurs outside of harlequin range in Alberta. The results of recent regional inventories and research initiatives has increased knowledge of the distribution and abundance of the Harlequin Duck in Alberta and provides managers with a context for defining the status of the species.

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APPENDIX 1. Definitions of selected legal and protective designations.

A. Status of Alberta Wildlife rank lists (after Fisheries and Wildlife Management Division, in prep)

2000 Rank	1996 Rank	Definitions
At Risk	Red	Any species known to be at risk after formal assessment and designation as Endangered in Alberta or in Canada (in the part of the range that includes Alberta).
May be at Risk	Blue	Any species believed to be at risk. These species will require a detailed assessment for possible formal designation as Endangered or Vulnerable.
Sensitive	Yellow	Any species known to be, or believed to be, particularly sensitive to human activities or natural events.
Secure	Green	Any species known to be, or believed to be, not at risk.
Status Undetermined	Status Undetermined	Any species where not enough information exists to adequately use the ranking system (exceptional cases only).
Not Assessed	n/a	Any species known or believed to be present but which have not yet been evaluated.
Exotic/Alien	n/a	Any species that have been introduced as a result of human activity.
Extirpated/Extinct	n/a	Any species no longer thought to be present in the jurisdiction or are believed to be extinct.
Accidental/Vagrant	n/a	Any species occurring infrequently and unpredictably outside their usual range.

B. Alberta Wildlife Act

Species designated as 'endangered' under the Alberta Wildlife Act include those defined as 'endangered' or 'threatened' by *A Policy for the Management of Threatened Wildlife in Alberta* (Alberta Fish and Wildlife 1985):

Endangered	A species whose present existence in Alberta is in danger of extinction within the next decade.
Threatened	A species that is likely to become endangered if the factors causing its vulnerability are not reversed.

C. United States Endangered Species Act (after National Research Council 1995)

Endangered	Any species which is in danger of extinction throughout all or a significant portion of its range.
Threatened	Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

D. Committee on the Status of Endangered Wildlife in Canada (after COSEWIC 2001)

Extinct	A wildlife species that no longer exists.
Extirpated	A wildlife species that no longer exists in the wild in Canada, but exists elsewhere in the wild.
Endangered	A wildlife species that is facing imminent extirpation or extinction.
Threatened	A wildlife species that is likely to become an endangered species if nothing is done to reverse the factors leading to its extirpation or extinction.
Special Concern (Vulnerable)	A wildlife species of special concern because it is particularly sensitive to human activities or natural events, but does not include an extirpated, endangered or threatened species.
Not at Risk	A wildlife species that has been evaluated and found to be not at risk.
Indeterminate	A species for which there is insufficient scientific information to support status designations.

E. Heritage Status Ranks (after Nature Serve 2000)

G1/S1	**Critically Imperiled**: Critically imperiled globally because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction. Typically 5 or fewer occurrences or very few remaining individuals (<1,000) or acres (<2,000) or linear miles (<10).
G2/S2	**Imperiled**: Imperiled globally because of rarity or because of some factor(s) making it very vulnerable to extinction or elimination. Typically 6 to 20 occurrences or few remaining individuals (1,000 to 3,000) or acres (2,000 to 10,000) or linear miles (10 to 50).
G3/S3	**Vulnerable**: Vulnerable globally either because very rare and local throughout its range, found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extinction or elimination. Typically 21 to 100 occurrences or between 3,000 and 10,000 individuals.
G4/S4	**Apparently Secure**: Uncommon but not rare (although it may be rare in parts of its range, particularly on the periphery), and usually widespread. Apparently not vulnerable in most of its range, but possibly cause for long-term concern. Typically more than 100 occurrences and more than 10,000 individuals.
G5/S5	**Secure**: Common, widespread, and abundant (although it may be rare in parts of its range, particularly on the periphery). Not vulnerable in most of its range. Typically with considerably more than 100 occurrences and more than 10,000 individuals.
GX/SX	**Presumed Extirpated**—Element is believed to be extirpated from the nation or subnation*. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
GH/SH	**Possibly Extirpated** (Historical)—Element occurred historically in the nation or subnation*, and there is some expectation that it may be rediscovered. Its presence may not have been verified in the past 20 years. An element would become NH or SH without such a 20-year delay if the only known occurrences in a nation or subnation were destroyed or if it had been extensively and unsuccessfully looked for. Upon verification of an extant occurrence, NH or SH-ranked elements would typically receive an N1 or S1 rank. The NH or SH rank should be reserved for elements for which some effort has been made to relocate occurrences, rather than simply using this rank for all elements not known from verified extant occurrences.

APPENDIX 2. Harlequin Duck breeding status for Alberta waterbodies.

Place Name	Location	Status (a)	Source (b)	Comments
Smoky River Watershed				
Beaverdam Creek	83 L/3	Unknown	2. 45.	2♂ 1♀ May 16 1997; 2♂ 1♀ May 27 1998
Copton Creek	83 L/3	Unknown	2.	1♂ May 27 1998
Cote Creek	Mouth to headwaters 83 E/13, 83 E/14	Probable	2. 7. 21.	5♂ 4♀ May 26 1999 air survey; 5♂ 3♀ June 1 2000 air survey
Famm Creek	83 E/13	Unknown	2.	2♀ July 20 1990
Fetherstonhaugh Creek	Mouth to headwaters 83 E/13	Unknown	2. 7.	1♀ May 26 1999 air survey
Hardscrabble Creek	83 E/11	Probable	21	5♂ 3♀ June 1 2000 air survey
Jackpine River	Mouth to headwaters 83 E/12	Probable	2. 7.	8♂ 10♀ May 26 1999 air survey
Kakwa River	83 L/4	Unknown	2. 7.	♀ and 7ducklings July 30 1978; 1 pair June 1 1999 air survey
Lick Creek	83 L/5	Probable	2.	1 pair observed annually
Muddywater River	Mouth to headwaters 83 E/13, 83 E/14	Probable	2. 7. 21.	8♂ 11♀ May 26 1999 air survey; 9♂ 5♀ June 1 2000 air survey
Muskeg River	Mason Creek to headwaters 83 E/10, 83 E/15	Breeding	2. 14. 15. 21.	brood July 5 1991; 6♂ 7♀ June 9 & 10 1997; 12♂ 11♀ May 26 1998 air survey; 4♂ 4♀ May 31 2000 air survey
Narraway River	83 L/12	Unknown	44.	historical report 1944
Nose Creek	83 L/13	Unknown	44.	historical report 1944
Putzy Creek	83 L/4	Unknown	2. 7.	1♂ June 1 1999 air survey
Sheep Creek	Mouth to headwaters 83 E/13, 83 E/14	Probable	2. 7. 21.	1 pair May 28 1998; 8♂ 6♀ May 26 1999 air survey; 10♂ 8♀ June 1 2000 air survey
Smoky River	Rockslide Creek to headwaters 83 E/3, 83 E/6	Probable	2. 6. 19. 20.	9 records 1980-1992; 6♂ 7♀ June 10 & 11 1991
Stinking Creek	Formerly South Torrens River 83 L/5	Unknown	2. 7.	1♂ June 1 1999 air survey
Sulphur River	Brandy Creek to headwaters 83 E/10, 83 E/11	Breeding	2. 14. 21.	12♂ and 10♀, May 26 1998 air survey; 11♂ 13♀ 1 unclassified May 31 2000; 2 broods September 8 2000
South Sulphur River	83 E/10	Breeding	2. 21.	1 pair May 31 2000 air survey; 1 brood August 9 2000
Torrens River	83 L/4, 83 L/5	Probable	2. 7. 30. 44.	historical report 1944; 1♀ June 22 1977; 1 pair May 31 1979; 1 harlequin July 1997; 8♂ 7♀ June 1 1999 air survey
Two Lakes	83 L/5	Unknown	44.	historical report 1944
Twintree Lake	83 E/6	Unknown	2. 6. 20.	1 pair 1980; harlequins frequently observed
West Sulphur River	83 E/10, 83 E/11	Breeding	2. 11. 14. 21.	4 harlequins September 22 1986; 10♂ and 9♀ May 26 1998 air survey; 2♀ July 27 1999; 5♂ and 8♀ May 31 2000 air survey; 1 brood August 9 2000
Athabasca River Watershed				

APPENDIX 2. continued

Place Name	Location	Status (a)	Source (b)	Comments
Amethyst Lake	83 D/9	Unknown	2. 6. 20.	1 pair July 6 1978; regularly observed since 1991
Astoria River	83 D/9	Breeding	2. 6. 20.	2 pair June 28 1986; brood observed Astoria River (Chrome Lake)
Athabasca River	83 D/16, 83 E/1	Unknown	2. 6. 17. 18. 19. 20. 30.	important spring staging area between Miette and Snaring Rivers (18 pair June 1978) Earliest arrival April 21 1996, Virtually no fall observations. No broods in 58 records 1977-1997
Athabasca River	83 C/5, 83 C/12	Unknown	2. 6. 17. 19. 20.	spring staging Whirlpool River to above Chaba River (3 pair 1♂ May 21 1990). Earliest arrival April 25 1995, Virtually no fall observations. No broods in 25 records 1977-1997
Beaver Creek	83 C/13	Unknown	2.	1♀ June 27 1997
Beaver Lake	83 C/13	Unknown	2. 20.	1 pair May 26 1997; regularly observed since 1991
Berland River	HWY 40 to junction of Sunset Creek and North Berland Rivers 83 E/9, 83 E/10	probable	2. 14. 15. 21.	1 pair June 3 1997; 8 pair 2♂ May 26 1998 air survey; 7♂ and 7♀ May 31 2000 air survey
Berry's Creek	83 F/3	Unknown	2.	2 pair June 5 1997
Cabin Creek Pond	83 F/3	Unlikely	2.	1♂ June 8 1991 and May 18 1993
Cavell Lake	83 D/9	Unlikely	2. 27.	1♀ and 1♂duckling August 30 1917; possible migration observation
Chaba River	83 C/5	Unknown	2. 20.	1 pair observed in Long Lake adjacent to Chaba River June 5-13 1992 and July 18 1992; frequently observed since 1991
Cheviot Creek	West Mine Pit Pond 83 C/14	Unlikely	2. 4. 23.	individual loafing males May and June 1993-1995
Chrome Lake	83 D/9	Unknown	2. 6. 17.	2 pair June 28 1986; 1♂ June 29 1996
Drinnan Creek	83 F/4	Breeding	1. 2.	1 pair June 7 1997; brood August 25 1998
Drummond Creek	83 C/14	Breeding	2. 23. 4. 25. 26.	brood-rearing 1996-1999
Edith Lake	83 D/16	Unlikely	2.	1♂ May 6 1990
Edna Lake	83 E/1	Unlikely	2.	1♀ September 30 1982
Evelyn Creek	83 C/13	Breeding	2. 18.	brood 1995
Excelsior Creek	83 C/13	Breeding	2. 18.	brood August 21 1994
Falls Creek Pond	83 F/3	Unlikely	2.	brood observed during migration late August 1993
Fiddle River	83 F/4	Breeding	2.	brood July 11 1996
Fryatt Creek	83 C/12	Unknown	2. 6. 19.	brood August 13 1978
Fryatt Lake	83 C/12	Unknown	2. 6. 20.	spring staging; regular observations since 1991
Gregg River	83 F/3, 83 F/4	Breeding	1. 2.	1 pair May 13 1990; brood August 3 1997 and August 14 1998
Hardisty Creek	83 C/12	Breeding	17.	brood reports
Harlequin Creek	83 C/13 83 C/14	Unlikely	2. 23.	2♀ July 19 1996

APPENDIX 2. continued

Place Name	Location	Status (a)	Source (b)	Comments
Amethyst Lake	83 D/9	Unknown	2. 6. 20.	1 pair July 6 1978; regularly observed since 1991
Harris Creek	83 C/14	Breeding	2. 23. 25. 26.	1♀ July 16 1996; ♀ June 13-July 10 1998; brood July 19 1999
Heart Lake	83 C/6	Unlikely	2.	1 pair May 25 1993
Hendrickson Creek	83 E/16	Unknown	2.	1 pair May 14 1990
Horseshoe Lake	83 C/13	Unlikely	2.	1♂ May 20 1992
Jacques Lake	83 C/13	Unknown	2. 6. 17.	spring staging area; 3 pair June 3 1979; 8♂ 7♀ June 9 1997; 6 additional spring records; 1♀August 21 1997
Jasper Sewage Ponds	83 D/16	Unlikely	2. 6.	7♂ 5♀ June 20 1979; 1♂ 2♀ May 21 1991
Jonas Creek	83 C/6	Unknown	2.	2♀ July 25 1993
Kerkeslin Creek	83 C/12	Breeding	2. 6.	pairs observed May and June, brood observed August 20 1979 and September 22 1991
Lac des Roches	83 F/3	Unlikely	2.	1♂ spring 1990; 6 harlequins September 21 1994
Lick Creek	83 C/5, 83 C/12	Unknown	2. 17.	brood reported during 1983 biophysical
Little Berland River	83 E/9	Probable	2. 14.	4 pair 1♀ May 26 1998 air survey
Luscar Creek	83 F/3	Breeding	2. 23. 24. 26.	spring staging area for pairs
Mackenzie Creek	83 C/14, 83 F/3	Breeding	2. 4. 23.	2♀ July 25 1995; 1 duckling August 10 1995; 1 brood August 23 1996; 1996 population estimated 4-5 pair
Maligne Lake	83 C/11, 83 C/12	Breeding	2. 6. 18. 19.	1 pair June 7 1976; important for pairs in spring; use by broods
Maligne River	83 C/12, 83 C/13, 83 D/16	Breeding	2. 6. 11. 18. 19. 27.	4 adults June 29 1985; lower Maligne used by pairs and broods, club site at Maligne Lake Outlet, broods on upper Maligne; maximum count in Maligne Valley for 1993, 1994, 1995 was 29, 41, 61 adults
McLeod River	Antler Creek to headwaters 83 F/3, 83 C/14	Breeding	2. 4. 7. 14. 23. 24. 25. 26.	2♂ 1♀ May 14 1966; brood July 7 1989; spring staging and brood-rearing; May 1999 population estimate 68±2 adults
Medicine Lake	83 C/13	Breeding	2. 6. 18. 19. 27.	8♂ 2♀ June 6 1946; high use of delta area by pairs and broods 1990-1997
Medicine Tent River	Lakes at pass 83 C/11	Breeding	2.	brood August 18 1997
Miette River	83 D/16	Unlikely	2. 19.	5♂ August 24 1992
Milk Creek	83 E/7	Unknown	2. 6.	1 pair June 8 1991
Moon Creek	83 E/9	Unknown	2.	1 pair May 29 1990; harlequin observations near mouth of Star Creek early June 1998
Mowitch Creek	83 E/7	Probable	2. 6.	brood July 12 1981; 1 pair June 26 1978, May 16 1980; 2 pair June 17 1982; 1 pair June 10 & 14 1991
North Berland River	83 E/10	Breeding	2. 14. 21.	3 pair May 26 1998 air survey; 7♂ 6♀, May 31 2000; 3 broods September 8

APPENDIX 2. continued

Place Name	Location	Status (a)	Source (b)	Comments
Amethyst Lake	83 D/9	Unknown	2. 6. 20.	1 pair July 6 1978; regularly observed since 1991
				2000
Osborne Creek	83 C/13	Unknown	2. 6.	2♀ June 4 1979
Patricia Lake	83 D/16	Unknown	2.	1 pair May 5 1997
Penstock Creek	83 D/9	Unknown	2. 19.	1 pair June 27 1992
Poboktan Creek	83 C/6	Breeding	2. 6. 19.	1 pair June 2 1979; brood August 14 1993
Prospect Creek	83 C/14	Breeding	2. 4. 23. 24. 25. 26	historical records early 1980's; 1 pair June 6 1996; brood August 21 1996, August 22 1997, July 5 1998
Pyramid Creek	83 D/16	Probable	2. 19.	early spring use by 1-2 pairs and males 1992-1997
Pyramid Lake	83 D/16	Unknown	2. 19.	1 pair October 19 1992
Rock Creek	83 E/7	Breeding	2.	nest July 6 1996; brood July 25 1999
Rocky River	83 C/11, 83 C/13, 83 C/14	Breeding	2. 6. 19. 27.	brood observed July 19 1944, August 15 1979, and July 21 1993
Simla Creek	83 E/7	Unknown	2. 6.	brood August 7 1980
Simon Creek	83 D/9	Unknown	2. 6.	2♂ 1♀ June 26 1978
Snake Indian River	83 E/7	Unknown	2. 6.	brood August 7 1980; pair June 10 1991
Solomon Creek	83 F/5	Probable	2. 15.	4 pair, 1♂ May 26 1997 instream survey
South Berland River	83 E/10	Breeding	2. 14. 21.	5 pair, 2♂ May 26 1998 air survey; 8♂ 9♀ May 31 2000; 2 broods August 10 2000
South Drinnan Creek	83 F/4	Breeding	1. 2.	nest June 18 1997
Sphinx Creek	83 F/4	Breeding	2.	brood observed August 1 1996
Sucker Creek	83 D/16	Unknown	2.	spring staging area; 7 pair May 21 1993
Sunwapta Lake	83 C/3	Unlikely	2. 6. 19.	1 pair June 11 1978; 1♀ May 20 1992
Sunwapta River	83 C/6, 83 C/12	Probable	2. 6. 19. 20.	spring use by pairs 1978-1996; 2 pair May 23 1992; earliest arrival April 29 1991
Surprise Lake	83 C/13	Unlikely	2.	2 ♂ 1♀ June 8 1995
Thornton Creek	83 C/14	Breeding	2. 4. 23. 26.	1 ♂ July 4 1979, 1 pair May 20 1994 and June 5 1995
Topaz Creek	83 E/7	Unknown	2. 20. 27.	recorded during 1943 and 1944 field work
Unnamed Creek	Creek draining Jacques Lake 83 C/13	Breeding	2. 6.	brood observations downstream of lake August 15 1979 and September 24 1996
Unnamed Creek	Tributary to the Snake Indian River 83 E/2	Unknown	2. 6.	1 ♀ June 28 1980
Unnamed Creek	Tributary to Wildhay River 83 E/8	Unknown	2.	1♀ May 20 1982
Unnamed Creek	Tributary to McLeod River	Breeding	24	nest June 13 1998

APPENDIX 2. continued

Place Name	Location	Status (a)	Source (b)	Comments
Amethyst Lake	83 D/9	Unknown	2. 6. 20.	1 pair July 6 1978; regularly observed since 1991
	83 C/14			
Warren Creek	83 C/11	Probable	2. 18.	2♀ July 21 1996
Watchtower Creek	83 C/13	Breeding	2. 18. 19.	brood July 29 1992
Welbourne Creek	83 E/8	Breeding	2.	brood August 29 1996
West Gate Pond	83 D/16	Unlikely	2. 19.	1 pair May 3 1992
Whirlpool River	83 D/8, 83 D/9, 83 C/12	Probable	2. 6. 19. 20.	3♂ 2♀ June 26 1978; harlequins frequently observed since 1991
Whitehorse Creek	83 C/14	Breeding	2. 4. 23. 24. 25. 26. 46.	3 unclassified July 23 1977; spring use by pairs; brood-rearing confirmed 1996-1999
Wildhay River	83 E/8, 83 E/ 9, 83 E/10, 83 F/12	Probable	2. 7. 15. 21.	3♂ 2♀ May 23 1997 instream survey downstream of Willmore Wilderness boundary; 6♂ 6♀ May 1999 air survey upstream of Willmore Wilderness boundary; 8♂ 6♀, May 31 2000 air survey
Willow Creek	83 E/8	Unknown	2. 8.	1♀ June 23 1971; several sightings of both sexes 1972
North Saskatchewan River Watershed				
Arctomys Creek	82 N/15	Unknown	2. 6. 20.	1 brood July 25 1978
Blackstone River	83 C/9, 83 C/10	Breeding	2. 3. 14.	brood July 1996; 7 pair May 20 1998
Brazeau Lake	83 C/6	Unknown	2. 6. 20. 27.	historical records 1943 and 1944; summer staging; regularly observed since 1991; 10 harlequins July 8 1996
Brazeau River	83 C/6, 83 C/7	Breeding	2. 6. 14. 19.	brood July 21 1990, August 8 1992, July 25 1993 and August 15 1997; frequently observed since 1991
Bighorn River	83 C/8	Unknown	2. 14.	none observed during a May 28, 1998 air survey; 1 unclassified (possible duckling) above falls August 1998
Brown Creek	83 C/10	Unknown	2. 14.	1 pair May 28 1998 observed during air survey from trunk road to headwaters
Cairn River	83 C/11	Breeding	2. 6. 17.	brood reported in 1983 biophysical
Cardinal River	83 C/14, 83 C/15	Probable	2. 5. 14. 23. 24.	1 pair May 9 1994; 1996 population estimated 4-5 pair; 6♂ 4♀ May 27 1998 air survey
Clearwater River	83 B/4	Probable	2. 7.	observed regularly late April-early May 1978-1992; 3 pair May 21, 25 1999 air survey
Cline Creek	83 C/6	Breeding	2.	brood August 25 1966
Cline River	83 C/2	Unknown	2. 14.	1♀ May 28 1998 air survey
Cripple Creek	83 B/5	Unknown	2. 7.	1 pair May 21 1999 air survey; 1 pair June 21 1999
Dolomite Creek	82 N/9	Unknown	2. 6. 20.	1 pair June 19 1978
Elk Creek	83 B/4	Probable	2.	1 pair May 9 1980; regularly observed 1978-1992
Four Point Creek	83 C/6	Unknown	2.	1♀July 7 1990, 5♀ August 15 1992

APPENDIX 2. continued

Place Name	Location	Status (a)	Source (b)	Comments
Amethyst Lake	83 D/9	Unknown	2. 6. 20.	1 pair July 6 1978; regularly observed since 1991
Glacier Lake	82 N/15	Unknown	2.	3 pair June 15 1957
Hummingbird Creek	83 C/1	Unknown	2.	1 pair June 15 1991
North Ram River	83 B/5	Breeding	2. 7.	1 pair June 1990; males in early summer; brood observed consistently; 12 pair 4♂ observed May 21 1999 during air survey
North Saskatchewan River	Rampart Creek to Castleguard meadows 83 C/2, 83 C/3	Probable	2. 13.	2 unclassified August 6 1970; 1 pair June 11 1995; 3♂ 2♀ June 1 1996
North Saskatchewan River	Windy Point Abraham Lake 83 C/8	Unknown	2. 14.	1 pair May 11 1949; none observed during air survey from Cline River to 5km east of Banff National Park May 28 1998
Onion Creek	83 C/1	Probable	2.	regularly observed late April - early May1978-1992
Pinto Creek	83 B/5	Unknown	2. 7.	1 pair observed at junction with North Ram River May 21 1999 air survey
Ram River	Includes reaches below and above North Ram River (known as South Ram River) 82 N/16	Breeding	2. 7.	males in early summer, brood observed consistently 1970's through to 1980's; 1♀ July 8 1995, 2 pair May 25 1999 air survey
Rampart Creek	83 C/2	Unknown	2. 36.	1♀ August 15 1982
Redcap Creek	83 C/14	Breeding	2. 4.	1 brood July 20 1995
Ruby Creek	83 C/15	Unknown	2.	harlequins observed 1973
Siffleur River	82 N/9	Unknown	2. 6. 20.	1♀ August 15 1978
Southesk Lake	83 C/11	Unknown	2. 20. 27.	recorded during 1943 and 1944 field work; regularly observed since 1991
Timber Creek	82 O/13	Unknown	2.	occasional sightings 1978-1992
Trident Lake	82 N/16	Unknown	2.	1♂ August 25 1995
Unnamed Creek	Tributary to McDonald Creek 83 C/2	Breeding	2. 14.	brood August 11 1996; none observed on McDonald Creek on May 28 1998 air survey
Wapiabi River	83 C/8, 83 C/7	Probable	2. 14.	10♂ 13♀ May 28 1998 air survey
Warden Lake	82 N/15	Unlikely	2. 13. 20.	reported summer 1974
Waterfowl Lakes	82 N/15	Unlikely	2. 13. 36.	2 unclassified May 30 1973
Red Deer River Watershed				
Burnt Timber Creek	83 D/11	Unknown	2.	1♀ July 8 1991
Divide Creek	82 O/12	Breeding	2. 37.	1 YOY September 17 1996
Dormer River	82 O/12	Breeding	2. 40.	brood August 6 1997
Harrison Lake	82 O/12	Probable	2. 6. 36. 37.	3♀ July 26 1996; 2♀ August 7-16 1996; 2♀July 24 1997
Little Red Deer River	82 O/10	Unknown	2.	1♂ 1988
North Burnt Timber Creek	82 O/11	Unknown	2. 7.	1 pair, 1♂ observed during June 1 1999 air survey
Red Deer River	82 O/12	Unknown	2.	2 unclassified June 27 1996

APPENDIX 2. continued

Place Name	Location	Status (a)	Source (b)	Comments
Amethyst Lake	83 D/9	Unknown	2. 6. 20.	1 pair July 6 1978; regularly observed since 1991
Panther River	82 O/11	Unknown	2. 7. 30.	2♂ May 6 1976; 1 pair June 1 1999 air survey
Scotch Camp Creek	82 O/12	Breeding	2.	♀ July 15 1997; brood July 18-26 1997
Snowflake Creek	At Scotch Camp cabin 82 O/12	Breeding	2. 36.	brood August 15 1994; pair July 1 1996
Unnamed Lake	Cirque north of Harrison Lake 82 O/12	Unknown	2. 6.	5 unclassified July 22 1986
Wigmore Creek	Observations in creek and pool near Windy Cabin 82 O/12	Probable	2. 36. 37. 40.	1♂ 2 unclassified June 15 1990; 1♀June 24 1995; 1♀July 13 1996; 2♀ July 19 1996; 1♂ May 31 1997
Bow River Watershed				
Altrude Creek	82 O/5	Unknown	2. 36.	1 pair May 20 1979
Baker Creek	82 N/8	Breeding	2. 40.	5♂ 5♀ May 11 1997; one brood September 3-October 14 1997
Barrier Lake	82 O/2	Unlikely	2. 30. 41. 43.	1 pair May 11 1971; 1 pair May 8-19 1998; 1♀ July 13 and 16 1999
Bow Lake	82 N/9	Unknown	2. 13. 20.	reported in 1974; 1♀ September 25 1997
Bow River	82 N/8, 82 N/9, 82 O/3, 82 O/4, 82 O/5, 82 N/5	Breeding	2. 6. 9. 10. 11. 16. 20. 29. 36. 37. 40.	earliest record 5♂ 3♀June 8 1907; 1998 population estimate 157±36; important spring staging area; 81 harlequins May 15 1997 between Outlet Creek and Castle Junction; 12 harlequins May 5 1997 between Banff and east park boundary; important brood rearing; nest location
Brewster Creek	82 O/4	Breeding	2. 36.	1♀ May 29 1992; brood August 1 1995, July 30 1996
Bryant Creek	82 J/13, 82 J/14	Breeding	2. 6. 20. 36. 37.	1♀ July 15 1977, June 22 1986; 1 pair May 11 1994; brood September 21 1996
Canyon Creek	82 J/2	Unknown	2. 39.	1 pair May 15 1997
Cascade River	Upstream of Cuthead Creek 82 O/5	Breeding	2. 36. 37.	1 pair June 3 1993; brood July 28 1995, September 7 1996
Cataract Creek	82 J/7	Breeding	2. 39. 43. 47.	2 harlequins May 14 1979; brood August 14 1997; 4 pair May 30 1999
Cliff Creek	82 J/10	Unknown	2.	brood August 20 1976
Consolation Lakes	82 N/8	Breeding	42	brood August 1, 1998
Cuthead Creek	82 O/5	Breeding	2. 37.	brood July 17 1996
Dyson Creek	82 J/10	Unknown	2.	1 pair June 22 1975; duckling August 14 1983
Elbow River	Between Paddy's Flats and Little Elbow Campground 82 J/15	Breeding	2. 29. 30. 38. 41. 47.	earliest record 1 pair June 6 1958; 1997 population estimate 27±5 adult harlequins; 1998 estimate 23±4
Etherington Creek	82 J/7	Unknown	2. 38. 39.	1 pair May 18 1986; 2 harlequins July 11 1997
Ford Creek	82 J/15	Unknown	2. 41.	1♂ June 15 1998
Forty Mile Creek	82 O/4	Breeding	2. 36. 37.	1 pair June 5 1975, June 1 1994, June

APPENDIX 2. continued

Place Name	Location	Status (a)	Source (b)	Comments
Amethyst Lake	83 D/9	Unknown	2. 6. 20.	1 pair July 6 1978; regularly observed since 1991
				5 1996; brood June 26 1995
Gorge Creek	82 J/10	Unknown	2.	1 harlequin June 23 1954; 1♂ June 7 1955; 1♀ June 12 1976
Haiduk Lake	Pond near lake 82 N/16	Breeding	2.	brood July 28 1994
Healy Creek	82 O/4	Breeding	2. 13. 20. 36. 37.	reported May 22 1966; 2♂ May 31 1979; 1 brood July 27 1995 and July 15 1996
Hector Lake	82 N/9	Breeding	2. 36. 40.	1 brood August 15 1994 and July 19 1997
Highwood River	Vicinity of junction with Cataract Creek 82 I/13, 82 J/7	Breeding	2. 38. 41. 47.	reported in 1979; 2 broods August 15 1996
Johnston Creek	82 O/4	Probable	2. 37. 40.	1♀ July 4 1995; 2 pair May 19 1997
Johnson Lake	82 O/3	Unlikely	2. 40.	1♂ May 20 1995; 1♀ May 18 1997
Jumpingpound Creek	Under road bridge 82 O/2	Unknown	2. 11. 38. 41.	1♂ May 29 1998 Jumpingpound Creek; also 2 unclassified harlequins July 20 1985 on "Sibbald Flats" (either Jumpingpound or Sibbald Creek)
Junction Creek	82 J/10	Unknown	2.	2♀ 1♂ June 7 1955; record for June 4 1995
Kananaskis River	Concentrations near Wasootch, Ribbon, Smith Dorrien Creeks 82 J/11, 82 J/14	Breeding	2. 10. 29. 38. 39. 41. 47.	earliest record 1 pair June 10 1961; 6 pair and 6♂ reported in 1997; 1998 population estimate 41±8; broods 1996 and 1997
Lake Annette	82 N/8	Breeding	2. 36. 37.	brood August 3 1995; 1♀ June 29 1997
Lake Minnewanka	82 O/3, 82 O/6	Unlikely	2. 6. 20. 36. 37.	spring staging; 1 pair May 28 1987; 2♂ 1♀ May 16 1996; 1♂ 1♀ May 29 1997
Lorrette Ponds	82 J/14	Unlikely	2. 29.	1♂ April 23 1996
Lower Kananaskis Lake	82 J/11	Unlikely	2. 38. 39. 43.	spring staging; 2♂ 1♀ June 10 & 11 1961; 7♂ 4♀ May 16 1988; 5♂ 2♀ May 19 1996; 1 pair May 30 1999
Marvel Lake	82 J/13	Breeding	2. 37.	brood August 9 1996
Molar Creek	82 N/9	Breeding	2. 36.	1♀ June 28 1992; brood August 3 1995
Moraine Creek	82 N/8	Breeding	2. 6. 20. 40.	2♂ June 17 1975; 2 separate nest locations and broods 1997
Moraine Lake	82 N/8	Breeding	2. 6. 36. 37. 40.	spring and summer staging; 1 pair June 21 1909; 1♀ 5 unclassified August 20 1977; 2♂ 1♀ May 27 1993; 10♀ July 31 1997; brood observed August 4-12 1995, August 15 1988, July 21-August 29 1997
Owl Lake	82 J/13	Unknown	2. 6.	brood August 29 1985; no other observations
Panorama Creek	82 N/8	Breeding	2. 40.	1♀ June 17-21 1997; 1 duckling September 11 1997
Paradise Creek	82 N/8	Breeding	2. 40.	brood 1997

APPENDIX 2. continued

Place Name	Location	Status (a)	Source (b)	Comments
Amethyst Lake	83 D/9	Unknown	2. 6. 20.	1 pair July 6 1978; regularly observed since 1991
Pipestone River	82 N/8, 82 N/9	Breeding	2. 40.	1 pair May 12 1992; brood July 16 1997
Pocaterra Creek	82 J/11	Unknown	2. 38. 39.	1♀ June 10 & July 19 1988; pair May 29 1997
Prairie Creek	82 J/15	Unknown	2. 41.	1♀ flying up creek summer 1998
Quirk Creek	82 J/15	Unknown	2. 38.	1 pair June 29 1992
Ranger Creek	82 J/15	Unknown	2. 38.	1 male June 24 1992
Ribbon Creek	82 J/14	Breeding	2. 38. 39.	brood August 6 1996; 4♀ August 3 1997
Sawback Lake	82 O/5	Unknown	2. 36.	1♀ July 2 1943 in beaver pond below lake
Sheep River	Between Blue Rock Creek and Indian Oils 82 J/10	Breeding	2. 29. 38. 39. 47.	2♂ June 8 1959; nest June 1963; brood observations July 18-September 8 1975, July 12-September 1 1976, June 27-July 29 1996, August 22 1997; 2 pair 1♂ 1997
Smith Dorrien Creek	82 J/11	Breeding	2. 38. 41.	2♂ 3♀ June 8 1995; brood September 12 1995; 2 broods 1998
Smith Lake	82 O/4	Unlikely	2. 39.	1♂ June 6 1997
Spray Lakes Reservoir	82 J/14	Breeding	2.	brood July 11 1991
Spray River	82 J/14, 82 O/3	Breeding	2. 38. 39.	1 pair May 14 1994; brood reported 1996 and 1997
Stoney Creek	82 O/5	Unknown	2. 13. 20.	reported May 9 1968
Storm Creek	82 J/10	Breeding	2. 40.	brood August 8 1997
Taylor Lake	82 N/8	Unlikely	42	1♀, July 12, 1998 in tarn near Taylor Lake
Two Jack Canal	82 O/4	Unlikely	2. 40.	1♂ July 14 1997
Two Jack Lake	82 O/3	Unlikely	2. 37. 40.	1♂ May 5 1996; 1 pair May 24 1996, May 18 1997
Unnamed Creek	Tributary to the Bow River 82 N/8	Breeding	2. 40.	1♀ June 17-July 9 1997; nest location
Unnamed Lake	Locally known as Loon Lake 82 J/11	Unknown	43	1 pair May 5 1999
Upper Kananaskis Lake	82 J/11	Unlikely	2. 38. 41. 43.	1♂ September 30 1967, June 21 1968, July 2 1992, June 12 1997; 1 pair June 13 1995, June 26 & July 9 1998, May 16 1999
Vermillion Lakes	82 O/4	Unlikely	2. 5.	1 unclassified September 1977
Ware Creek	82 J/9	Unknown	2. 39.	1♂ May 25 1997
Oldman River Watershed				
Blakiston Creek	82 G/1	Breeding	2. 20. 35.	harlequins common in valley as early as 1957; brood July 25 1972 and reported in 1990
Cameron Creek	82 H/4	Unknown	2. 20.	4♂ 1992
Cameron Lake	82 G/1	Unknown	2. 35.	2♂ November 8 1968
Carbondale River	82 G/8	Breeding	2. 28.	1♂ and 1♀ May 25 1984; brood

APPENDIX 2. continued

Place Name	Location	Status (a)	Source (b)	Comments
Amethyst Lake	83 D/9	Unknown	2. 6. 20.	1 pair July 6 1978; regularly observed since 1991
				August 12 1997; 1♂ June 13 1998 and June 13 1999
Castle River	Upstream of junction with West Castle River (known as South Castle River) 82 G/8	Breeding	2.	brood August 1 1995 and July 17 1996; pair spring 1998
Crowsnest Lake	82 G/10	Unknown	2.	2 unclassified harlequins August 26 1940
Crowsnest Creek	A short distance SW of Crowsnest Lake 82 G/10	Unknown	2. 44.	brood August 26 1940
Little Crypt Lake	local name for pond at headwaters of Hell's Roaring Creek 82 H/4	Unknown	2. 20. 35.	brood September 16 1967 (may be migration)
Livingstone River	82 G/16	Probable	2. 28.	1♀ 1997; 1♂ 1♀ August 6 1998; 4♂ 3♀ May 17 2000 air survey
Lower Waterton Lake	82 H/4	Unknown	2. 20. 30. 31. 35.	spring staging 8♂ 4♀ May 16 1979; fall migration
Lynx Creek	82 G/8	Breeding	2. 28.	2♂ June 8 1997; 3♂ 5♀June 13 1998; 2♀ 8YOY August 9 1998; 1♂ 2♀ June 13 1999
North Belly River	82 H/4	Breeding	2.	brood 1996
Oldman River	82 G/16	Breeding	2. 28.	1 harlequin July 25-28 1959; 5 harlequins June 18 1992; brood August 15 1996; 9♀ 21YOY Aug 6 1998; 10♀ 32ducklings Aug 10 1999
Pincher Creek	82 G/8	Unknown	2.	1♂ 1995
Racehorse Creek	82 G/16	Breeding	2.	brood 1996; 1 pair May 17, 2000 air survey
Rowe Creek	82 G/1	Unknown	2.	unconfirmed brood reports
Upper Waterton Lake	82 H/4	Unknown	2. 20. 31.	historical records; 1 pair near townsite 1992 migratory bird survey
Waterton River	82 H/4, 82 H/6	Unknown	2. 20.	males observed annually at HWY 6 bridge
West Castle River	82 G/8	Breeding	2.	1 harlequin July 29 1959; brood reported 1996
Yarrow Creek	82 G/1	Unknown	2.	1♂ 1995
Alberta outside Foothills and Mountains				
Beaverhill Lake	Tofield 82 H/7	Unlikely	2. 29. 30.	1♂ May 1 1965; 1♂ June 13 1996; 1♀ September 21 1991
Bow River	Calgary 82 I/13, 82 J/16, 82 O/1	Unlikely	2. 29.	winter record 1 immature ♂ November 8 1972 - March 20 1973; December records 1992 1993 1995
Chipewyan Lakes	84 A/14	Unlikely	2.	1♀ specimen at U of Alberta
Cold Lake	73 L/8	Unlikely	2. 11. 29.	fall and winter records 1987-1995
Cooking Lake	83 H/6	Unlikely	2. 32.	historical report
Fleming Lake	Caribou Mountains 84 J/14	Unlikely	2. 32.	historical report
Gregoire Lake	74 D/6	Unlikely	2. 30. 32.	1 pair May 30 1976

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(c) Nomenclature from: Energy, Mines and Resources Canada. 1988. Gazetteer of Canada, Alberta, Third Edition. Supply and Services Canada, Cat. No. M86-11/1988. Ottawa, ON 64pp.

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